

An Analysis of the Use of Incentive/Disincentive Contracting Provisions for Early Project Completion¹

DENNIS L. CHRISTIANSEN
TEXAS TRANSPORTATION INSTITUTE

Across the United States, transportation agencies have embarked on a major effort to upgrade the nation's overburdened and aging urban freeways, sometimes simultaneously adding public transportation facilities such as high-occupancy-vehicle (HOV) lanes. In most cases, the construction work involved in both must be carried on while the existing facility continues to carry heavy traffic volumes.

No matter how carefully planned and executed, such construction work delays and frustrates the very public the projects are intended to serve. There is a clear national consensus that these projects should be built as fast as possible to cut the length of time the traveling public must endure the inconveniences of construction work. Moreover, the sooner such projects are done, the sooner the public will benefit from them.

One of the ways used to get construction contractors to work faster is to offer them a financial incentive to do so—and also assess them a financial penalty if they do not meet schedules. Contract language covering such matters is called an incentive/disincentive (I/D) provision or clause.

In Houston, Texas, the Metropolitan Transit Authority of Harris County (METRO), in cooperation with the Texas State Department of Highways and Public Transportation (SDHPT), used I/D provisions to expedite a joint project to construct a transitway in an existing freeway median while the freeway was being rehabilitated. This project, the first of its kind for both agencies, was successfully completed ahead of schedule, but not without some difficulty for both contractor and agency personnel.

At METRO's request, the Texas Transportation Institute (TTI) examined both the benefits and difficulties resulting from the effort to speed up the pace of this (and other) projects. The institute also reviewed current practice with I/D provisions elsewhere to help identify ways to speed up future construction projects while minimizing the adverse effects of the additional effort needed to do so.

The findings of the TTI study are presented here in condensed form. Experience with incentive/disincentive contracts is still limited. Few reports about completed

¹ This paper and the following outline by David S. Gendell formed the basis of the panel discussion on construction and contract issues.

I/D projects have been published. Accordingly, quantitative data are insufficient to support rigorous statistical analyses upon which to base firm conclusions. Fortunately, however, many of the people directly involved with I/D projects across the nation were willing to relate their recent experience in interviews.

PROJECT BACKGROUND

In the early 1980s, METRO and SDHPT agreed to replace a successful experimental 9.6-mile HOV contraflow lane on Interstate 45 (I-45) immediately north of downtown Houston with a permanent transitway called an authorized vehicle lane (AVL) in the median of the freeway. Both agencies wanted the contraflow operation to cease as soon as possible. To do so, a strategy was devised in which the overall work required (in excess of \$50 million) was divided into a series of contracts, one of which would provide a narrow interim AVL at the earliest date possible. This \$8.2 million contract, called Phase 1B, included both AVL and remedial freeway work, and it employed I/D provisions to encourage the contractor to expedite the AVL portion.

The Phase 1B contract required prospective contractors to bid both time and money, a process often called (A + B) bidding. Contractors had to specify the number of days it would take to open the interim AVL to traffic. The successful bidder was the one whose construction cost plus the number of days bid multiplied by \$5,000 was the lowest. (The \$5,000 figure was derived from an estimate of administrative and construction engineering and inspection costs as well as the cost of operating the contraflow lane.) However, this amount was for low-bid determination only; the contractor was paid solely for work done.

To stimulate an even faster opening of the interim AVL, the contract provided an incentive of \$5,000 for each day the contractor could cut from the time he had bid, up to a maximum of 90 days (making the maximum incentive payment possible \$450,000). The contract provided an identical disincentive for failure to make the time bid. In this case the contractor bid 360 days for opening the AVL. He actually did so in 269 days, thereby earning the full \$450,000 incentive. The overall work in the \$8.2 million Phase 1B contract was finished in 470 days instead of the 540 days allowed by the contract. The project began in December 1983, the interim AVL was opened on September 14, 1984, and the Phase 1B contract was completed on April 13, 1985.

In January 1985 METRO awarded the next contract in the series (Phase 2), a \$43.4 million project to provide the permanent AVL (as well as freeway reconstruction). The techniques employed were similar. The successful contractor selected 750 calendar days' working time (as opposed to the minimum time bid of 720 days allowed in the invitation to bid). The incentive was \$6,000 per day up to a maximum of 170 days (\$1,020,000). The disincentive (and the value used for time cost in bid determination) was \$12,000 per day. By May 1986 Phase 2 was slightly more than 60 percent complete and the contractor was on a schedule that roughly extrapolated optimistically to a 720-750 day completion time.

On both the Phase 1B and Phase 2 contracts, METRO was the contracting and financing agency (with UMTA funding assistance), and SDHPT performed project engineering and inspection. On a subsequent contract to extend the AVL about five miles farther north, the SDHPT handled all functions (with FHWA funding assistance). This project (called Phase 3) did not utilize incentive provisions.

GENERAL FINDINGS

From extensive interviews with individuals experienced in I/D projects and from a careful review of the completed Phase 1B contract and the ongoing Phase 2 contract, it has been possible to arrive at some general answers to questions that have been raised about contracts with I/D provisions.

How much sooner can an I/D project be constructed compared with a project contracted in the usual way?

Experience to date indicates that I/D projects can be completed in approximately half the time, often saving a year or more.

How much more does it cost to do so?

It is generally conceded that it costs the contractor from 10 percent to 20 percent more, most of which is passed on to the contracting agency. In addition, the agency may have to bear the cost of the early-completion incentive, which usually is about 5 percent of the contract amount.

How extensively have contracts with I/D provisions been used and with what success?

To date, at least 58 contracts with I/D provisions have been awarded in 30 states. So far, it appears that about 95 percent of the contracts that have been completed have finished on time or sooner. In Texas, in addition to the two METRO-SDHPT projects on I-45, the SDHPT has recently awarded three more contracts with I/D provisions: a \$39.8 million contract on the Dallas North Central Expressway (US-75) with a \$10,000/day incentive; a \$46.8 million contract on West Beltway 8 in Houston, also with a \$10,000/day incentive; and a \$6.3 million contract in Houston on Spur 548 with a \$3,000/day incentive. All three of these projects began in 1986. It is too early to determine whether the I/D provisions have speeded progress.

Shouldn't I/D provisions be used more often if they work so well?

I/D contracts are an effective, nationally accepted means of completing projects early. However, those with experience strongly recommend that I/D contracts not be used routinely; their use should be limited to those projects whose construction would severely disrupt traffic or transit service, significantly increase roadway user costs, create safety problems, or substantially affect adjacent business, or whose early completion would provide a major improvement in transportation.

Are there ways to get contractors to speed up their work rates without paying them an incentive?

Yes—but probably not to the degree that an I/D contract can attain. Nevertheless, some techniques have been used successfully:

- Louisiana standard specifications contain a provision for disqualifying a contractor from bidding or subcontracting other projects when he is substantially behind schedule on a contract.
- Texas has a special provision that has been used successfully on five out of six contracts. It provides that succeeding larger amounts (30 to 50 percent) of the monthly payment due the contractor for work done be withheld should he fall behind a schedule approved by critical path method (CPM) analysis.
- California specifies in the plans when the contract working time or an extensive traffic control plan or both will require the contractor to work two shifts.
- High liquidated damages have been used by several states where the basis of the liquidated damage value has included costs other than those incurred

by the agency for construction engineering and inspection during the period of contract time overrun. This practice may not stand up in court or receive federal approval and its use is not recommended.

IMPACTS OF PROJECT ACCELERATION AND OTHER FINDINGS

Project Acceleration Impacts

- The cost of accelerating the Phase 1B contract was offset by the benefits derived:
 - Cost of acceleration: \$450,000¹
 - Benefits of acceleration²: \$5.1 million to \$26.8 million
- The 24-hr/day, 7-day/week work schedule used on the project resulted in extremely severe working conditions for an understaffed SDHPT inspection work force. More personnel and less overtime were needed.
- The contractor and his personnel also experienced adverse effects attributed to the intense effort to accelerate the work rate, as follows:

Project	Size of Work Force	Workers Hired	Turnover Rate (%)	Avg Wage Rate (\$)	Work-Related Accidents	Relative Insurance Rate
Phase 1B	100	700	600	15.42	411	1.3
Conventional ³	100	200	100	10.00	50	1.0

- Correspondence and paperwork increased an estimated two to three times normal levels because the contractor documented every occurrence that might allow a claim for time if he failed to earn the incentive he had planned for.
- Administratively, SDHPT had an organization in place; METRO had to establish one. Although the METRO administrative group performed well, it would have benefited from the addition of two people to handle the work load generated by the contractor's round-the-clock schedule.
- Keeping the contraflow lane and the interim AVL in operation through the construction work zone cost the contractor an estimated \$75,000 to \$100,000 per year.
- During construction, contraflow use fell an estimated 15 to 20 percent, which was attributable at least in part to poor contraflow operating conditions that resulted from the accelerated construction work. Use rebounded after the AVL opened; however, vanpools are now declining, probably from the employment drop in downtown Houston caused by declining oil prices.
- From 1983 to 1985, average annual 24-hr traffic volumes on I-45 at the midpoint of the Phase 1B project increased from 177,000 to 197,000 vehicles per day, indicating that the reasons for accelerating the transitway construction were even stronger than originally believed.
- Analysis of bidding for Phase 1B and Phase 2 contracts is inconclusive. The Phase 1B contractor's bid was 7.8 percent below the engineer's estimate; the Phase 2 contractor's bid was 9.2 percent above the engineer's estimate. But both contractors underbid their nearest competitor by \$2.064 million (20.1 percent) and \$5.689 million (11.7 percent), respectively.

¹ Incentive only; construction cost bid was less than engineer's estimate.

² For only the reduction in user-delay costs resulting from construction, depending on assumptions made for time saved and user cost values.

³ Estimated average.

- On neither Phase 1B nor Phase 2 did bidding of contract time (A + B bidding) influence the outcome.
- When the Phase 2 contract was 60 percent complete, it appeared unlikely that the contractor would be able to earn much of the incentive available.

Other Findings

- Federal and Texas officials support the use of I/D provisions when such provisions are warranted.
- I/D provisions should not be used on projects that have key elements sensitive to weather, or where significant adjustments to pay quantities might be anticipated.
- The efficacy of requiring bids for both cost and time (A + B bidding) is still in question and is considered experimental by federal officials. Those interviewed knew of only one case where (A + B) bidding was the factor that decided the successful bidder.
- If a project warrants acceleration, contract time should be measured in calendar days instead of working days.
- For I/D projects, completion times must be realistic. They should be established by methods such as CPM analysis performed by those experienced in both the analysis techniques and construction practices.
- On I/D projects, close coordination among the contractor, METRO-SDHPT, and federal agencies is critical. Decisionmaking and approval authority (for field changes, shop drawings, etc.) must be available whenever the contractor works. At night and on weekends, all involved offices should have designated contact persons.
- For I/D projects, small interagency task forces for both preconstruction and construction phases have been helpful in expediting projects. Before construction, the group advises project design staff, reviews the projects accelerated and I/D provisions, and helps set up future interagency procedures to ensure timely contract decisions, field change approval, shop drawing review, and so on. During construction, the task force meets frequently and regularly with the contractor to (a) expedite the procedures mentioned above, (b) reduce the amount of paperwork that naturally accompanies accelerated contracts with I/D provisions, and (c) find ways to avoid conflicts and delays rather than dealing with them after they occur.
- A contractor's past and current performance record should be taken into account by either prequalification or disqualification provisions.
- Nationally, daily I/D rates have varied from \$3,000/day to \$30,000/day for recent projects of roughly the same order of magnitude. In many cases with the lower values, user delay costs have been reduced by administrative decision (or not used at all) apparently to forestall possible criticism of, or challenges to, the assumptions used.
- User delay costs resulting from construction are acceptable to federal officials as one of the factors in computing the daily I/D values.
- On I/D projects, the contractor must deploy many crews simultaneously, requiring more subcontracting than usual. Federal regulations permit 70 percent of the work to be subcontracted; most other agencies do likewise for I/D contracts.

RECOMMENDATIONS

Deciding which projects should be contracted with I/D provisions should be done well before plans are complete to provide time to ensure that project design,

specifications, schedules, and so on, are compatible with the contractual approach selected.

Most guidelines for selection of projects for I/D provisions suggest that the project have the following characteristics:

1. High delay costs to road users that can be attributed to delay resulting from construction activity.
2. High traffic volumes generally found in urban areas.
3. Involvement with major reconstruction of an existing freeway.
4. Benefits, in terms of cost savings and/or safety, that outweigh the cost of incentive payments and additional construction cost.

But nearly all of the METRO/SDHPT planned transitways have these characteristics—and the same guidelines state that I/D provisions should be limited to only the most critical projects. To differentiate between the many projects that need to have their construction schedule accelerated and the few that should use I/D provisions to do so, the following procedure is suggested.

Classify Projects

Three categories are used:

1. Conventional—does not have the characteristics noted above. The normal contracting method is used.
2. Accelerated—has above characteristics; merits accelerated construction pace over conventional contracting. (Most of the transitways fall in this category.)
3. Incentive (I/D)—a special case of the accelerated category. These projects would have one or more of the following additional characteristics:
 - Some useful part of the contract can be done well before the rest of the work and is of significant benefit to the public (e.g., early use of an AVL or freeway main lane).
 - Is a prerequisite to the use of some other project (e.g., to fill a gap or remove a serious bottleneck).
 - Is needed by a specific date to provide service to some other traffic generator (e.g., a new school).
 - Is located on a freeway with a traffic density above 15,000 vehicles per day per lane of average weekday traffic within the project limits.
 - Involves the prolonged closure of one or more freeway lanes.

Compute Contract Time

For accelerated projects, computation of contract time is a very important factor. For I/D projects, it is critical. Those who compute contract time must choose assumptions that are appropriate to the urgency of the project but that will not result in a schedule so tight that few, if any, contractors would bid on the project. The following approach to estimating contract time is suggested:

- For accelerated and I/D projects, measure contract time on a calendar-day basis, but preclude work on Sundays and national holidays except for emergencies.
- The number of days allowed the contractor to do the work should come from a careful CPM network analysis performed by individuals experienced in both the

CPM and construction. The level of contractor work effort to be used in making the CPM analysis for each category is suggested below:

<i>Project Classification</i>	<i>Working Period (hr/work week)</i>
Conventional	One shift: 40-60
Accelerated	Two shifts: 96
Incentive (I/D)	Two shifts: 120

Accelerated Projects Without I/D Provisions

For accelerated projects without I/D provisions, plans and specifications should clearly specify that the contractor is expected to exert extra effort and should also include ways to encourage him to do so. Such ways could include

- A note that more than one shift will be necessary to meet the schedule (usually with Traffic Control Plan notes).
- A provision that disqualifies the contractor from bidding on other projects if he falls substantially behind schedule.
- A provision to withhold part of the monthly payment due the contractor if he falls behind schedule.
- A carefully calculated value for liquidated damages, utilizing the most recent salary and other costs involved in construction engineering and inspection and based on the staff necessary to oversee for the number of hours per week that would have to be worked to meet the project deadline.

I/D Projects

1. The duration of the incentive period should be no longer than the difference in time between that computed for an accelerated project and that computed for an I/D project.
2. The maximum incentive payment to the contractor should be established. This amount should be approximately 5 percent of project cost.
3. The daily I/D rate should be computed by dividing the amount arrived at in the previous step by the number of days calculated in step 1. To determine whether the daily rate so computed is justifiable, daily costs associated with user delay from construction, construction engineering, and so on, should be computed by using such tools as SDHPT's computer model HEEM-II or *A Manual on User Benefit Analysis of Highway and Bus Transit Improvements* (AASHTO, 1977). In the event that such analyses do not justify the daily rate computed, it (and the maximum incentive) should be scaled down accordingly. However, any project where these values are less than 60 percent of the computed daily rate probably should not use I/D provisions. For I/D projects, the liquidated damage value should be stated separately.
4. As noted earlier, the effectiveness of requiring the contractor to specify contract time by bidding (A + B bidding) is still under debate. Its use is not recommended. If it is to be used, it is recommended that the full value of user delay costs associated with construction be employed to compute time cost; in no case should this be less than the daily I/D rate.
5. The preconstruction task force mentioned in preceding sections should review the I/D values before final adoption to make sure they accord with project and economic conditions.

6. Before the bidding, adequate agency staff should be ensured for a full contractor work week, which can be as long as 120 hours. If agency personnel levels are not sufficient, outside firms should be retained to assist in the effort.
7. Before construction, night and weekend contact persons should be specified in writing.
8. As a follow-up to the preconstruction task force, a small construction task force should be established to meet regularly with the contractor in the manner discussed in preceding sections.